QUANTITATIVE SPECTROSCOPY IN PULSED POWER DEVICES

Contract No. N00014-87-K2019

Submitted to
Office of Naval Research

Principal Investigator: H. R. Griem

April 1, 1987 - March 31, 1988

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SUMMARY

This report covers the second stage of an experimental research project directed towards the development of ultrashort wavelength lasers involving pulsed power devices rather than cylindrically focused high power lasers. During this second stage, modifications to the construction of the pinch source have been made, and a redesign of the pinch container and pumping mechanism with the aim of enhancing certain diagnostics has been undertaken. Diagnostic equipment has been procured, constructed, installed, and tested. In addition, a data acquisition system has been procured and is being installed. Further diagnostic equipment has been ordered. The experiment has progressed well into the developmental stage.

EXPERIMENTAL PROGRAM

Modifications were made to the construction of the small Z-pinch which reduced the current risetime of the discharge, improved the framing camera photographs and considerably eased difficulties with interferometer alignment. The Z-pinch will be used for study of line profiles that are relevant to soft x-ray researchers. Present studies concentrate on discharges in methane.

Experiments are presently being conducted with the experimental setup of the Z-pinch as shown in Fig. 1. In the near future a second 1 meter N.I. VUV spectrometer will be added (see Fig. 1). It will be used as a monochromator to assist in the choice of timing for the time gated

spectra to be taken with the new VUV spectrometer.

The framing camera diagnostic has been modified to permit greater control over the timing and exposure of photographs. The framing camera can now be gated from 5 ns to 1 μs. Originally the fastest practical gating was 100 ns. Recent framing camera studies (see Fig. 2) demonstrate the growth of instabilities, and mixing in the discharge. Turbulent mixing of the discharge may be responsible for rapid cooling, thereby augmenting recombination. Rapid recombination is the proposed mechanism for a population inversion between candidate levels in lithium-like ions.

The construction of the interferometer was completed and it has been installed and tested (see Fig. 3). A preliminary estimate of the radially averaged electron density has been obtained ($5.0 \times 10^{17} cm^{-3}$) and refinements are planned to improve the performance of this diagnostic.

The new 1 meter Vacuum-Ultraviolet spectrometer equipped with a micro-channel plate detector that was originally tested at the Maryland Theta-pinch was installed recently at the Z-pinch upon the completion of an adaptor/protector mechanism. We are now in the process of testing it and are preparing it to take spectra. This instrument will also be equipped with a new more sensitive phosphor.

A data acquisition system has been procured. It comprises a Camac crate with a GPIB controller, several Camac modules (fast digitizers and fan in, fan outs), a GPIB interface bus/interface board, and an Everex 1800 (an IBM-AT compatible) computer with supporting software. Installation and testing of this system are now in progress. It will greatly enhance our capability for data acquisition, analysis, and presentation.

Earlier preliminary studies of time histories of several lines of

interest revealed what are possibly bright recombination peaks (see Fig. 4). Further time history studies will be conducted in the near future.

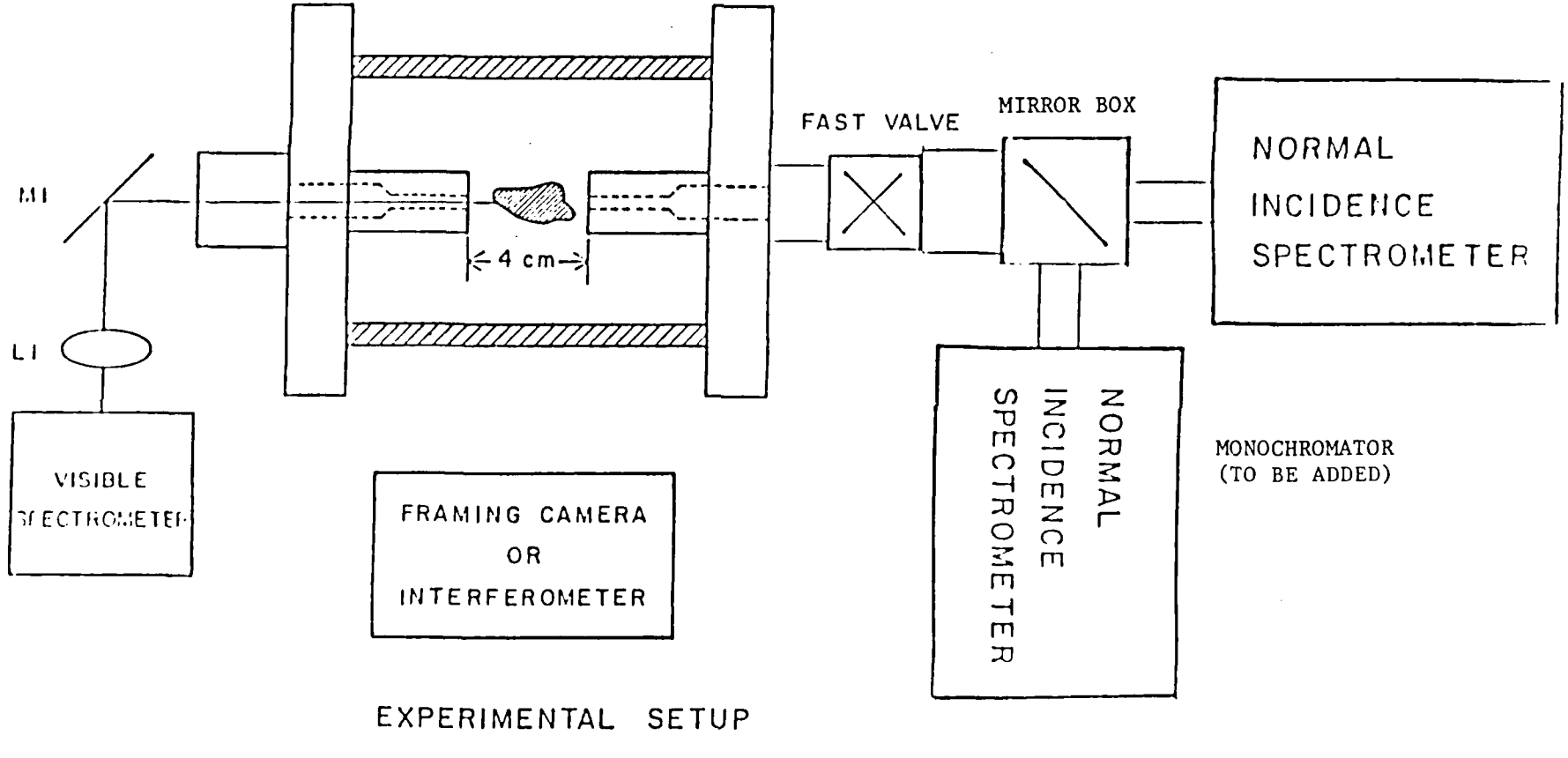
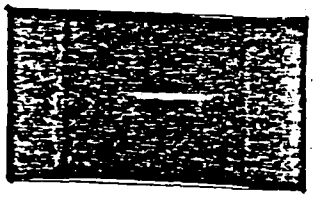


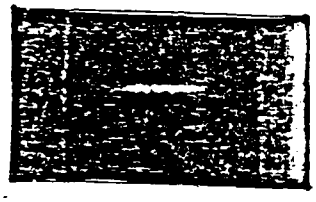
Figure 1. Experimental Setup.

FILM = Polaroid type 107C.	PRESSURE = 150 mTorr Methane.
DISTANCE = 4.5 feet.	VOLTAGE = 10 kV.
EXPOSURE TIME = 5 ns.	PEAK CURRENT = 80 kA.
FRAMING CAMERA = Cordin model 5118.	CURRENT RISETIME = 2.9 μs
T = Various	ELECTRODES = Arkonite.
F = Various	ELECTRODE SEPERATION = 4 cm.



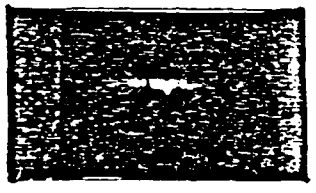
T = 1.0 μs

F = 5.6



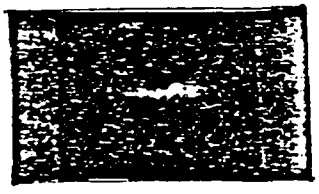
T = 1.57 μs

F = 5.6



T = 1.80 μs

F = 5.6



T = 2.04 μs

F = 8

T = 2.60 μs

F = 11

Figure 2. Framing Camera Photographs.

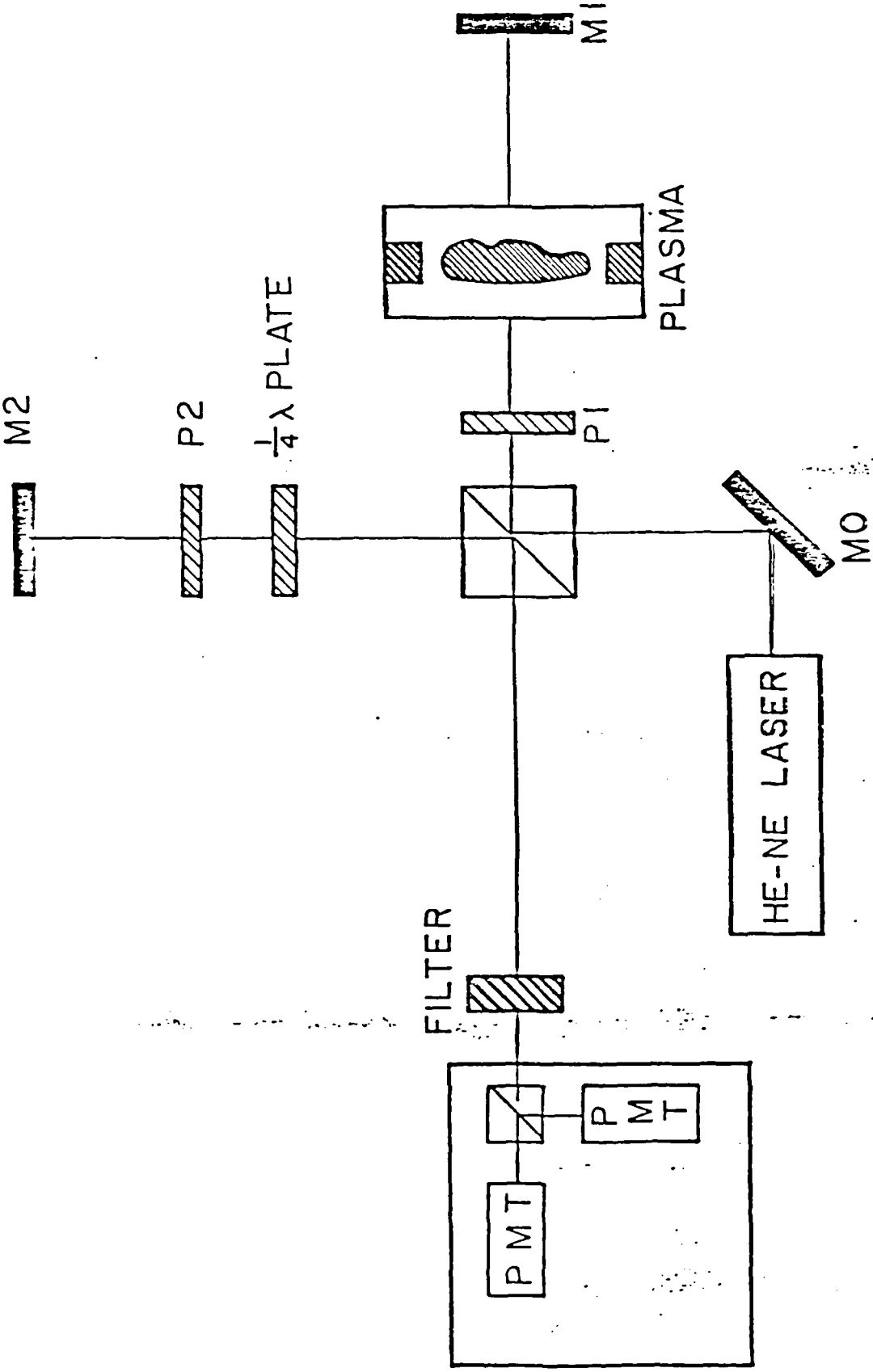


Figure 3. Interferometry.

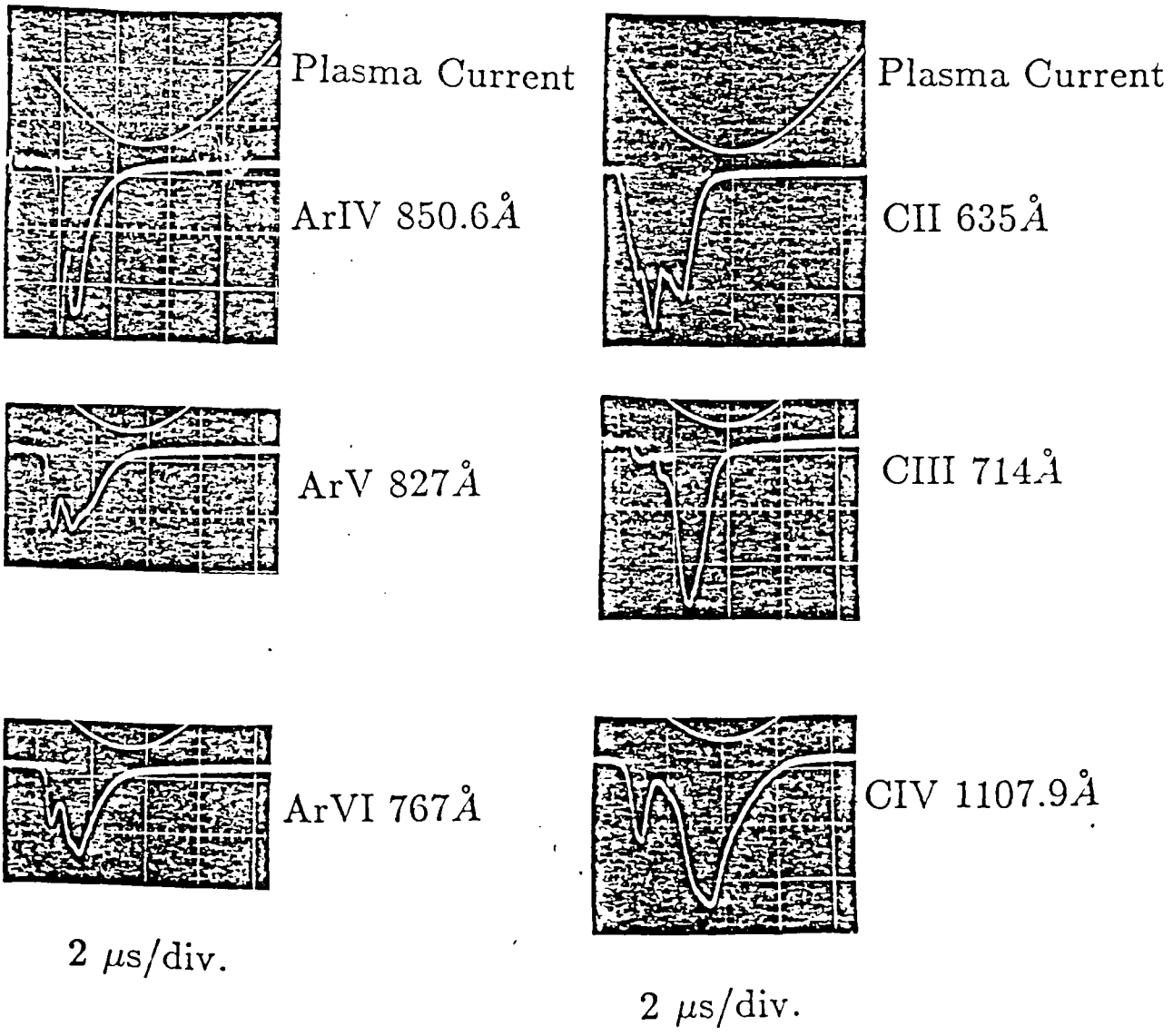


Figure 4. Time Histories of Spectral Lines.

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